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(54) **PIXEL STRUCTURE, LCD PANEL, AND MANUFACTURING METHOD THEREOF**

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**H01L 27/12** (2006.01)

**G02F 1/1368** (2006.01)

(52) **U.S. Cl.**

CPC ..... **H01L 27/1288** (2013.01); **G02F 1/1368** (2013.01); **G02F 1/133555** (2013.01); **H01L 27/124** (2013.01)

(58) **Field of Classification Search**

CPC ..... G02F 1/133555; G02F 1/133553

USPC ..... 349/114

See application file for complete search history.

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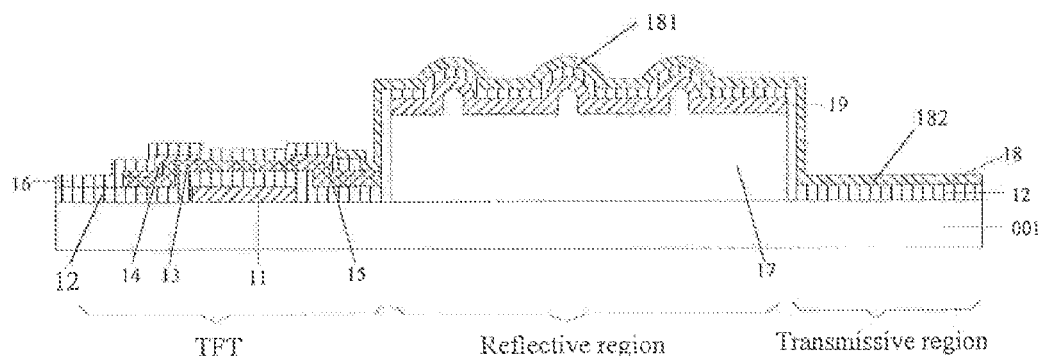
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(57) **ABSTRACT**

An embodiment of the disclosed technology provides a pixel structure, comprising a TFT, a reflective region and a transmissive region, wherein the reflective region comprises a reflective region insulation layer, a reflection layer on the reflective region insulation layer and a reflective region pixel electrode on the reflection layer, and the transmissive region comprises a transmissive region pixel electrode, wherein the reflective region pixel electrode and the transmissive region pixel electrode form an integral structure, and the integral structure of the pixel electrodes is connected with the drain electrode of the TFT, wherein the organic layer in the reflective region is formed on an array substrate prior to a gate electrode of the TFT, and the reflection layer in the reflective region and the gate electrode of the TFT are formed in a same patterning process by using a same metal layer.

**13 Claims, 2 Drawing Sheets**



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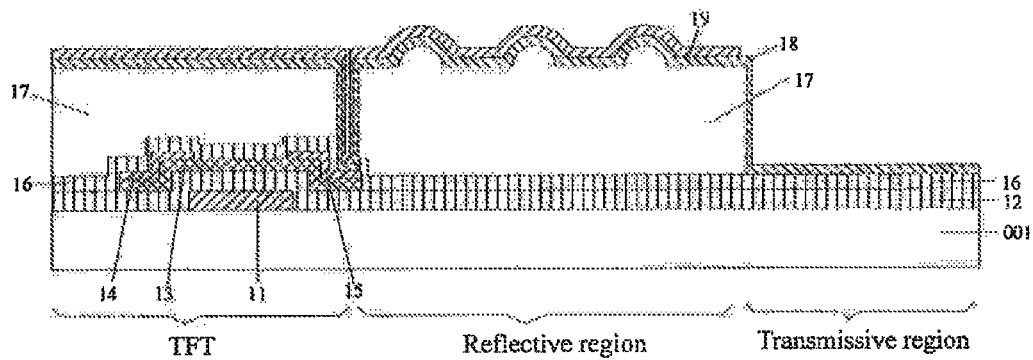


Fig.1

(PRIOR ART)

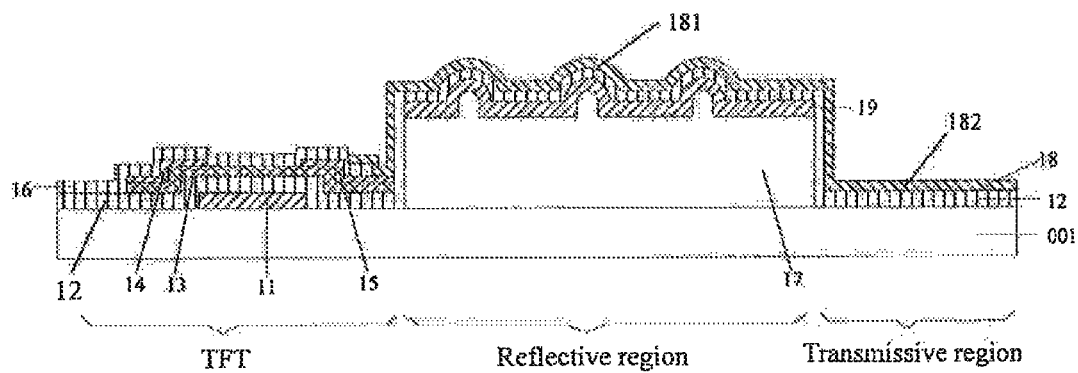


Fig.2

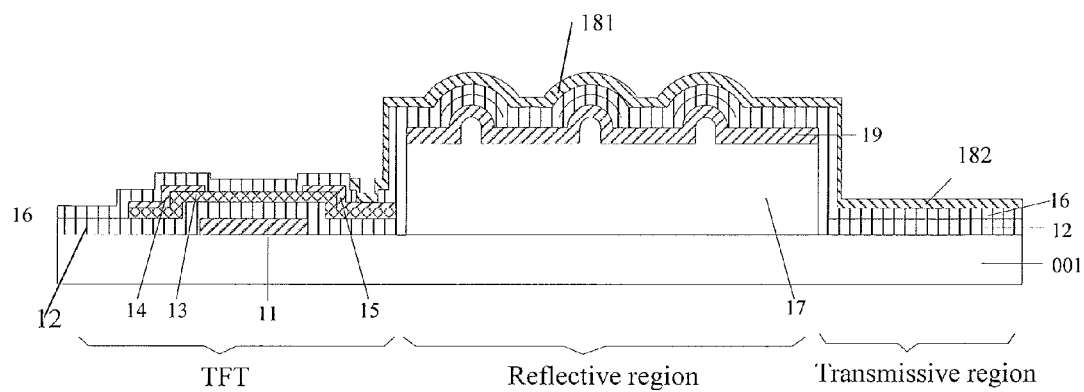


Fig.3

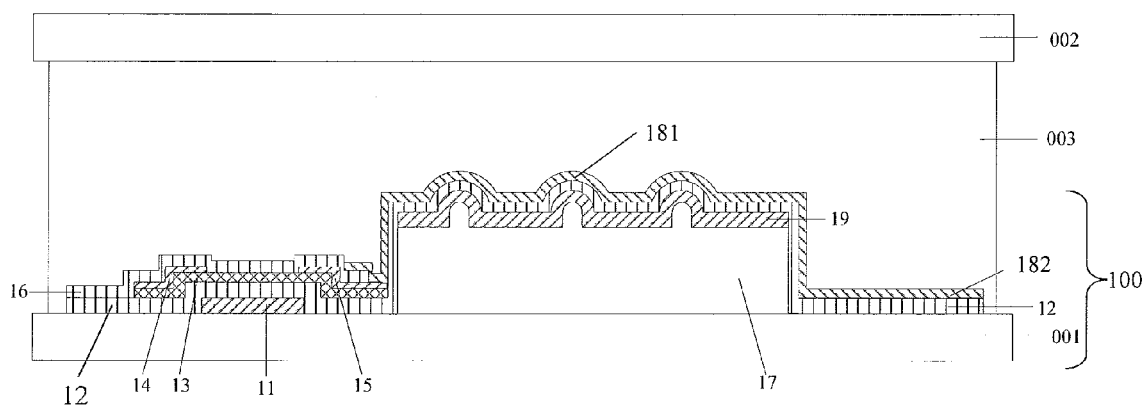


Fig.4

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# PIXEL STRUCTURE, LCD PANEL, AND MANUFACTURING METHOD THEREOF

## BACKGROUND

Embodiments of the disclosed technology relate to a pixel structure, a liquid crystal display (LCD) panel and a manufacturing method of an LCD panel.

The thin film transistor liquid crystal displays (TFT-LCDs) currently widely applied are mostly of a full-transmissive type. The full-transmissive type LCDs have a poor contrast when used outdoor for example in the sunshine, resulting in bad panel readability. To overcome this defect, a transreflective LCD has been proposed. The transreflective LCD improves the contrast of the outdoor LCD by increasing the reflectivity of the panel so that the panel may keep a good outdoor readability.

As shown in FIG. 1, a pixel structure (that is, the structure of a pixel) on an base substrate **001** of a conventional transreflective LCD comprises: a gate electrode **11** of a thin film transistor (TFT), a gate insulating layer **12**, an active layer **13**, source/drain electrodes **14/15** of the TFT, a passivation layer **16**, an organic layer **17**, a pixel electrode **18** and a reflection layer **19**. Such a pixel structure may be divided into three regions, i.e., a TFT region, a reflective region, and a transmissive region. A manufacturing method for the pixel structure shown in FIG. 1 may comprise the following steps.

Step 1 of preparing a gate metal film on a base substrate, and forming the gate electrode **11** and a gate line through a photolithography process using a mask;

Step 2 of preparing a silicon nitride film on the array substrate after step 1 to form the gate insulating layer **12** and preparing a semiconductor film to form the active layer **13** through a photolithography process using a mask;

Step 3 of preparing a source/drain metal film on the array substrate after step 2, and forming a gate line and the source electrode **14** and the drain electrode **15** of the TFT through a photolithography process using a mask;

Step 4 of preparing a silicon nitride film on the array substrate after step 3, and forming the passivation layer **16** by forming a via hole in the silicon nitride film through a photolithography process using a mask;

Step 5 of preparing an organic film on the array substrate after step 4, and forming the organic layer **17** through a photolithography process using a gray tone mask;

Step 6 of preparing a pixel electrode film on the array substrate after step 5, and forming the pixel electrode **18** through a photolithography process using a mask; and

Step 7 of preparing a reflective metal film on the array substrate after step 6, and forming the reflection layer **19** through a photolithography process using a mask.

It can be seen from the above manufacturing process that seven photolithography processes are adopted in the conventional manufacturing method for the pixel structure shown in FIG. 1, which results in a complex process.

## SUMMARY

An embodiment of the disclosed technology provides a pixel structure, comprising a thin film transistor (TFT), a reflective region and a transmissive region, wherein the reflective region comprises a reflective region insulation layer, a reflection layer on the reflective region insulation layer and a reflective region pixel electrode on the reflection layer, and the transmissive region comprises a transmissive region pixel electrode, wherein the reflective region pixel electrode and the transmissive region pixel electrode form an

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integral structure, and the reflection layer in the reflective region and the gate electrode of the TFT are formed in a same patterning process by using a same metal layer.

Another embodiment of the disclosed technology provides an LCD panel, comprising an array substrate, a color filter substrate and a liquid crystal layer interposed therebetween, wherein the array substrate comprise a pixel structure, the pixel structure comprising: a thin film transistor (TFT), a reflective region and a transmissive region, wherein the reflective region comprises a reflective region insulation layer, a reflection layer on the reflective region insulation layer and a reflective region pixel electrode on the reflection layer, and the transmissive region comprises a transmissive region pixel electrode, wherein the reflective region pixel electrode and the transmissive region pixel electrode form an integral structure, and the reflection layer in the reflective region and the gate electrode of the TFT are formed in a same patterning process by using a same metal layer.

Further another embodiment of the disclosed technology provides a manufacturing method for a pixel structure, comprising preparing an organic film on a base substrate and forming a reflective region insulation layer through a photolithography process using a mask; preparing a gate metal film on the base substrate and forming a gate electrode of a thin film transistor (TFT), a reflection layer and a gate line through a photolithography process using a mask, wherein the reflection layer is formed on the reflective region layer; sequentially forming a gate insulating layer, an active layer, a source/drain metal layer, a passivation layer, and a reflective region pixel electrode and a transmissive region pixel electrode which form an integral structure.

Further scope of applicability of the disclosed technology will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the disclosed technology, are given by way of illustration only, since various changes and modifications within the spirit and scope of the disclosed technology will become apparent to those skilled in the art from the following detailed description.

## BRIEF DESCRIPTION OF THE DRAWINGS

The disclosed technology will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the disclosed technology and wherein:

FIG. 1 is a structural diagram of a pixel (pixel structure) of a conventional array substrate.

FIG. 2 is a cross-sectional view of a pixel of an array substrate according to an embodiment of the disclosed technology.

FIG. 3 is a cross-sectional view of another pixel on an array substrate according to an embodiment of the disclosed technology.

FIG. 4 is a cross-sectional view of an LCD panel according to an embodiment of the disclosed technology.

## DETAILED DESCRIPTION

The embodiment of the disclosed technology being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the disclosed technology, and

all such modifications as would be obvious to those skilled in the art are intended to be included within the scope of the following claims.

To simplify the manufacturing process for the pixel structure of a base substrate **001** for a transfective LCD, a pixel structure according to an embodiment of the disclosed technology is provided as shown in FIG. 2, which comprises a thin film transistor (TFT) region, a reflective region and a transmissive region, which are arranged side by side. The reflective region comprises an organic layer **17** as a reflective region insulation layer, a reflection layer **19**, and a reflective region pixel electrode **181**. The transmissive region comprises a transmissive region pixel electrode **182**. The TFT comprises a gate electrode **11**, a gate insulation layer **12**, an active layer **13**, a source electrode **14**, and a drain electrode **15** and is covered by a passivation **16**, and the TFT is connected to the pixel electrode **181**, **182** through a through hole formed in the passivation layer.

The pixel electrodes **181** and **182** in the reflective region and the transmissive region form pixel electrode **18** of an integral structure. The pixel electrode **18** is connected with the drain electrode **15** of the TFT. The organic layer **17** in the reflective region may be formed on the base substrate **001** prior to the gate electrode **11** of the TFT as an insulation layer in the reflective region to reduce the cell gap. The reflection layer **19** in the reflective region and the gate electrode **11** of the TFT can be formed in a same patterning process by using a same metal layer. The base substrate **001** may be a glass substrate, a plastic substrate, or the like.

The same metal layer may be one of Mo, Cu, Al or AlNd alloy or other alloys. The manufacturing of the gate electrode **11** and the reflection layer **19** in a same patterning process by using a same metal layer comprises preparing a gate metal film on the base substrate **001** having the organic layer **17** formed thereon through depositing or sputtering one of Mo, Cu, Al or AlNd alloy or other alloys, and forming the reflection layer **19** and the gate electrode **11** of the TFT through a photolithography process using one mask. At the same time, a gate line (not shown) is formed, and the gate electrode **11** may be branched from the gate line or a part of the gate line.

As in the pixel structure provided by the embodiment of the disclosed technology, the gate electrode **11** and the reflection layer **19** can be formed in a same patterning process by using a same metal layer, one masking process is thus omitted. The manufacturing process for the pixel structure on the base substrate **001** is simplified compared with the conventional process; thereby the production costs can be saved.

As shown in FIG. 2, only the gate insulating layer **12** is formed (i.e., left) between the pixel electrode **18** and the reflection layer **19** in the reflective region. In the manufacturing of the pixel structure, an insulating film such as a silicon nitride film is firstly prepared as a passivation layer **16** on the base substrate **001** after the source and drain electrodes **14**, **15** have been formed thereon, and then the insulating film is patterned by using a mask according to the shape of the passivation layer **16** shown in FIG. 2, thereby the passivation layer **16** shown in FIG. 2 is formed. In this end, between the pixel electrode **18** and the reflection layer **19**, the passivation layer **16** is removed but the gate insulating layer **12** is left in the reflective region.

Alternatively, both the gate insulating layer **12** and the passivation layer **16** may be formed (i.e., left) between the pixel electrode **18** and the reflection layer **19** in the reflective region. In the manufacturing of such a pixel structure, an insulating film such as a silicon nitride film is firstly prepared as a passivation on the base substrate **001** after the source and drain electrodes **14** and **15** have been formed thereon, and

then the insulating film is patterned by using a mask according to the shape of the passivation layer **16** shown in FIG. 3; that is, a via hole is formed, through which the drain electrode **15** of the TFT and the pixel electrode **18** are connected to each other, thereby the passivation layer **16** shown in FIG. 3 is formed. In this end, the gate insulating layer **12** and the passivation layer **16** are formed between the pixel electrode **18** and the reflection layer **19** in the reflective region.

Preferably, the reflection layer **19** has a cross-section of a wave shape, a sawtooth wave shape, or a triangular wave shape, for example. That is, the reflection layer has an uneven surface to enhance the light reflection effect. By forming the reflection layer **19** of such a shape, diffusion reflection of the incident light from outside can occur on the reflection layer **19**, such that reflected light can be more evenly distributed on various viewing angles.

The pixel structure shown in FIGS. 2-3 differ from each other in that different masks are used in forming (patterning) the passivation layer, and the manufacturing methods thereof do not have substantial difference. Both exemplary pixel structures can be made according to the following manufacturing method, which comprises the following steps.

Step A1 of preparing an organic film on a base substrate **001**, and forming the organic layer **17** through a photolithography process using a mask. The organic layer **17** is an example of the reflective insulation layer for reducing the cell gap in the reflective region.

The photolithography process using a mask (masking process) generally comprises processes such coating of photoresist, exposing and developing of photoresist, etching, removing of photoresist and so on. There may be two available types of photolithography processes using a mask in the embodiment of the disclosed technology, one of which makes use of a normal mask, the other makes use of a gray tone mask (or a half tone mask). The photolithography process using a gray tone or half tone mask is also referred to as a gray tone masking process. A normal mask or a gray tone mask is used in the industrial manufacturing according to practical requirements.

In an example, the step may be performed by preparing an organic film on the base substrate **001**, and forming the organic layer **17** having a cross-section profile of a wave shape, a sawtooth wave shape, or a triangular wave shape through a gray tone masking process. In this way, when the reflection layer **19** is formed in the subsequent step A2, the reflection layer **19** can have a section of a wave shape, a sawtooth wave shape, or a triangular wave shape.

Step A2 of preparing a gate metal film on the base substrate **001** after step A1, and forming the gate electrode **11** of the TFT, the reflection layer **19** and a gate line through a photolithography process using a mask.

As one layer of gate metal film is prepared in this step, and then the gate electrode **11** of the TFT, the reflection layer **19** and a gate line are formed through a photolithography process using a mask, thus the gate electrode **11** of the TFT and the reflection layer **19** are formed in a same patterning process by using a same metal layer.

The gate insulating layer **12**, the active layer **13**, the source/drain metal layer (including source and drain electrodes and a data line), the passivation layer and the pixel electrode **18** are sequentially formed over the base substrate **001** after step A2. The layers following step A2 may be formed according to conventional processes for example as follows.

Step A3 of preparing an insulating film as the gate insulating layer **12** on the resulted base substrate **001** after step A2; preparing a semiconductor film on the array substrate having the gate insulating layer formed thereon and then forming the

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active layer **13** through a photolithography process using one mask; preparing a source/drain metal film on the base substrate **001** having the semiconductor film formed thereon and forming a source/drain metal layer through a photolithography process using a mask. The source/drain metal layer comprising the source electrode **14** and the drain electrode **15** of the TFT and a data line which may be connected with the source electrode **14**.

Step **A4** of preparing an insulating film on the resulted base substrate **001** after step **A3**, and forming the passivation layer **16** shown in FIG. 2 or 3 through a photolithography process using a mask.

The shape and size of the passivation layer **16** shown in FIG. 2 or 3 are for illustration only; the scope of the disclosed technology is not limited thereto.

Step **A5** of preparing a pixel electrode film on the resulted base substrate **001** after step **5**, and forming the pixel electrode **18** through a photolithography process using a mask.

It can be seen from above, two masking processes are performed in step **A3** while only one masking process is performed in each of the other steps. As a result, only six photolithography processes are performed in the above-described manufacturing method for the pixel structure according to the embodiments of the disclosed technology. The number of photolithography processes is reduced by one compared with the conventional technology, thereby the manufacturing process is simplified. In addition, as the number of used masks is reduced, the production costs can be saved.

In addition, to order to further simplify the manufacturing process, the step for forming the active layer **13** and the source/drain metal layer may comprise sequentially preparing a semiconductor film and a source/drain metal film on the base substrate **001** having the gate insulating layer **12** formed thereon and forming the active layer **13** and the source/drain metal layer through a photolithography process using one mask. Specifically, the above step **A3** may comprise preparing an insulating film as the gate insulating layer **12** on the resulted base substrate **001** after step **A2**; preparing a semiconductor film and a source/drain metal film in this order on the base substrate **001** having the gate insulating layer **12** formed thereon, and forming the active layer **13** and the source/drain metal layer through a photolithography process using one gray tone mask. As the active layer **13** and the source/drain metal layer are completed through a photolithography processes using one gray tone mask, the pixel structure according to an embodiment of the disclosed technology may be finished through a photolithography process by using five masks, thereby the manufacturing process is further simplified and the production costs can be further saved.

As shown in FIG. 4, an embodiment of the disclosed technology provides an LCD panel comprising an array substrate **100**, a color filter substrate **002** and a liquid crystal layer **003** interposed therebetween. The array substrate **300** has a pixel structure formed on a base substrate **001**, which comprises a TFT, a reflective region and a transmissive region. The reflective region comprises an organic layer **17** as a reflective region insulation layer, a reflection layer **19**, and a pixel electrode **181**. The transmissive region comprises the pixel electrode **182**.

The pixel electrodes **181** and **182** in the reflective region and the transmissive region form a pixel electrode of an integral structure. The pixel electrode of the integral structure is connected with the drain electrode **15** of the TFT. The organic layer **17** in the reflective region may be formed on the base substrate **001** prior to the gate electrode **11** of the TFT.

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The reflection layer **19** in the reflective region and the gate electrode **11** of the TFT are formed in a same patterning process by using a same metal layer.

Preferably, the reflection layer **19** has a section of a wave shape, a sawtooth wave shape, or a triangular wave shape. That is, the reflection layer **19** has an uneven surface.

The array substrate **100** of the LCD panel shown in FIG. 4 is obtained with reference to FIG. 2. However, it can also be obtained with reference to FIG. 3. As shown in FIG. 2, the gate insulating layer **12** is left between the pixel electrode **18** and the reflection layer **19** in the reflective region. As shown in FIG. 3, both the gate insulating layer **12** and the passivation layer **16** are left between the pixel electrode **18** and the reflection layer **19** in the reflective region.

According to the LCD panel of an embodiment of the disclosed technology, the gate electrode **11** of the TFT and the reflection layer **19** are formed in a same patterning process using a same metal layer in the manufacturing of the pixel structure on the base substrate **001**. As a result, one masking process can be omitted. The manufacturing process for the pixel structure on the base substrate **001** can be simplified; thereby the production costs can be saved.

It should be appreciated that the embodiments described above are intended to illustrate but not limit the disclosed technology. Although the disclosed technology has been described in detail herein with reference to the preferred embodiments, it should be understood by those skilled in the art that the disclosed technology can be realized with different material and equipment as necessary, and that various modification and equivalents thereof can be made herein without departing from the spirit and scope of the disclosed technology.

What is claimed is:

1. A pixel structure, comprising  
a thin film transistor (TFT), a reflective region and a transmissive region,  
wherein the reflective region comprises a reflective region insulation layer, a reflection layer on the reflective region insulation layer and a reflective region pixel electrode on the reflection layer, and the transmissive region comprises a transmissive region pixel electrode,  
wherein the reflective region pixel electrode and the transmissive region pixel electrode form an integral structure, the reflection layer in the reflective region and the gate electrode of the TFT are formed in a same patterning process by using a same metal layer, and  
wherein a gate insulating layer is formed between the reflective region pixel electrode and the reflection layer in the reflective region.
2. The pixel structure of claim 1, wherein both a gate insulating layer and a passivation layer are formed between the reflective region pixel electrode and the reflection layer in the reflective region, and the passivation layer covers a source/drain metal layer.
3. The pixel structure of claim 1, wherein the reflection layer has a cross-section of a wave shape, a sawtooth wave shape, or a triangular wave shape.
4. The pixel structure of claim 1, wherein the reflective region insulation layer is an organic layer.
5. A liquid crystal display (LCD) panel, comprising:  
an array substrate, a color filter substrate and a liquid crystal layer interposed therebetween,  
wherein the array substrate comprise a pixel structure, the pixel structure comprising:  
a thin film transistor (TFT), a reflective region and a transmissive region,

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wherein the reflective region comprises a reflective region insulation layer, a reflection layer on the reflective region insulation layer and a reflective region pixel electrode on the reflection layer, and the transmissive region comprises a transmissive region pixel electrode,

wherein the reflective region pixel electrode and the transmissive region pixel electrode form an integral structure, the reflection layer in the reflective region and the gate electrode of the TFT are formed in a same patterning process by using a same metal layer, and wherein a gate insulating layer is formed between the reflective region pixel electrode and the reflection in the reflective region.

6. The LCD panel of claim 5, wherein both a gate insulating layer and a passivation layer are formed between the reflective region pixel electrode and the reflection layer in the reflective region, and the passivation layer covers a source/drain metal layer.

7. The LCD panel of claim 5, wherein the reflection layer has a cross-section of a wave shape, a sawtooth wave shape, or a triangular wave shape.

8. The LCD panel of claim 5, wherein the reflective region insulation layer is an organic layer.

9. A manufacturing method for a pixel structure, comprising

preparing an organic film on a base substrate and forming a reflective region insulation layer through a photolithography process using a mask;

preparing a gate metal film on the base substrate and forming a gate electrode of a thin film transistor (TFT), a reflection layer and a gate line through a photolithogra-

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phy process using a mask, wherein the reflection layer is formed on the reflective region insulation layer; sequentially forming a gate insulating layer, an active layer, a source/drain metal layer, a passivation layer, and a reflective region pixel electrode and a transmissive region pixel electrode which form an integral structure, wherein the gate insulating layer is formed between the reflective region pixel electrode and the reflection layer in the reflective region.

10. The method of claim 9, wherein the forming of the active layer and the source/drain metal layer comprises:

preparing a semiconductor film and a source/drain metal film on the base substrate having the gate insulating layer formed thereon, and

forming the active layer and the source/drain metal layer through a photolithography process using one mask.

11. The method of claim 9, wherein forming the reflective region insulation layer comprising:

preparing an insulation film on the base substrate, and forming the reflective region insulation layer having a section profile of a wave shape, a sawtooth wave shape, or a triangular wave shape through a gray tone masking process.

12. The method of claim 9, wherein both the gate insulating layer and the passivation layer are formed between the reflective region pixel electrode and the reflection layer in the reflective region, and the passivation layer covers the source/drain metal layer.

13. The method of claim 9, wherein the reflective region insulation layer is an organic layer.

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